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CONTAMINATED SOILS ADJACENT TO THE SEWAGE TREATMENT PLANT REMOVAL ACTION NUMBER 14 WORK PLAN JANUARY 1992

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CONTAMINATED SOILS ADJACENT TO THE SEWAGE TREATMENT PLANT

REMOVAL ACTION NUMBER 14 WORK PLAN

FERNALD SITE OFFICE
FERNALD, OHIO

JANUARY 1992

U.S. DEPARTMENT OF ENERGY

2689

CONTAMINATED SOILS ADJACENT TO THE SEWAGE TREATMENT PLANT INCINERATOR

REMOVAL ACTION #14 WORK PLAN

JANUARY 1992

U. S. Department of Energy
P. O. Box 398705
Cincinnati, Ohio 45239-8705

CONTAMINATED SOILS ADJACENT TO THE SEWAGE TREATMENT PLANT INCINERATOR

TABLE OF CONTENTS

SECTION:

1.0 Introduction
- 1.1 Fernald Site Background
- 1.2 Background of the Sewage Treatment Plant Area
- 1.3 Summary of Existing Data
- 1.4 Need for Removal Action
- 1.5 Objectives of Removal Action

2.0 Removal Action
- 2.1 Phase I
- 2.2 Phase II
- 2.3 Phase III

3.0 Program Management
- 3.1 Responsibilities
- 3.2 Schedule

4.0 Quality Assurance Plan

5.0 Health and Safety Plan

APPENDICES

I RSE
II Map of RI/FS Walkover Survey Data
III Sampling Grid Layout

1.0 INTRODUCTION

On September 20, 1991, the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA) jointly signed an Amended Consent Agreement establishing milestones for the implementation of Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) response actions at the Fernald Environmental Management Project (FEMP). One such milestone provided that the DOE submit a work plan to U.S. EPA by January 23, 1992 addressing Removal Action No. 14, Contaminated Soils Adjacent To The Sewage Treatment Plant Incinerator. This document provides the referenced work plan for Removal Action No. 14. The objective of the removal action is to remove the immediate threat to human health and the environment, until final remediation of this area can be accomplished. The DOE conducted a Removal Site Evaluation (RSE), Appendix I, to determine if conditions present in the soil in the Sewage Treatment Plant area warranted a removal action under CERCLA, consistent with Section 300.410 of the National Oil and Hazardous Substance Pollution Contingency Plan (NCP). Based upon the information in the RSE, the DOE issued an Action Memorandum stating that a Removal Action is warranted under authorities delegated to the DOE under Section 104 of CERCLA, through Executive Order 12580. The proposed removal action is protective of human health and the environment and will be conducted in accordance with all CERCLA requirements.

As shown in Figure 1, the Sewage Treatment Plant is located on the eastern edge of the FEMP reservation. The FEMP Sewage Treatment Plant has operated from 1952 to the present providing physical and biological treatment of FEMP wastewater. Also located at the Sewage Treatment Plant is an abandoned-in-place solid waste incinerator (see Figure 2). The incinerator operated from 1954 until 1979 burning combustible wastes generated from FEMP administrative and process areas. Process area wastes burned at the incinerator contained low levels of radioactive materials and potentially other hazardous substances.

As summarized in the attached RSE and the attached radiological walkover survey (see Appendix II), which employed a 2"x2" NaI Detector, characterization activities completed as part of the FEMP Environmental Monitoring Program and the Remedial Investigation/Feasibility Study (RI/FS) identified elevated concentrations of radionuclides in soils in the vicinity of the Sewage Treatment Plant. To date, no analysis has been completed for the possible presence of non-radiological hazardous substances in the soils in the study area. As evidenced by the findings of these characterization efforts, the highest activity concentrations of radiological constituents were predominantly found in the surface soils adjacent to the abandoned incinerator and adjacent to some of the operational facilities associated with sewage treatment.

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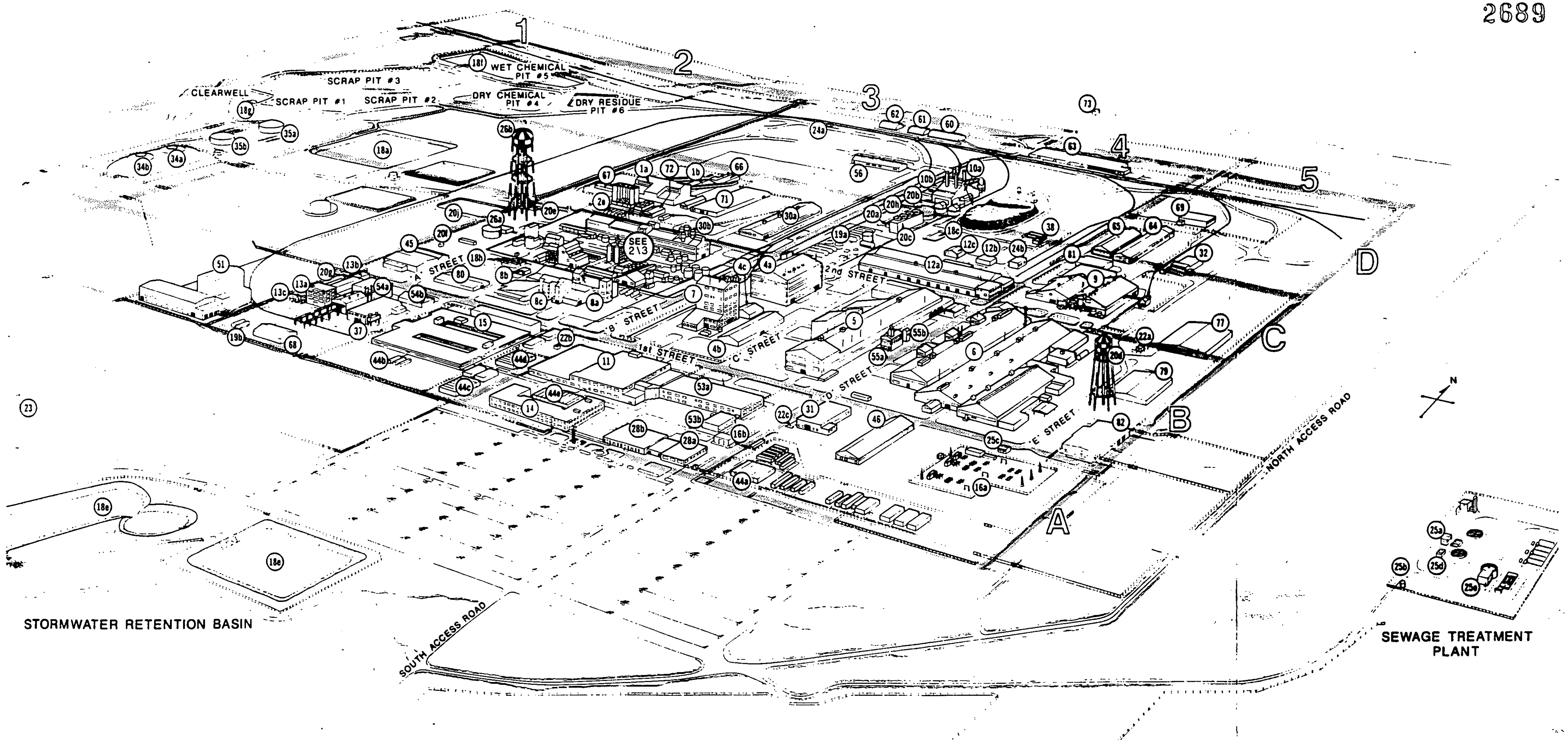

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Figure 1. FMPC Site Perspective

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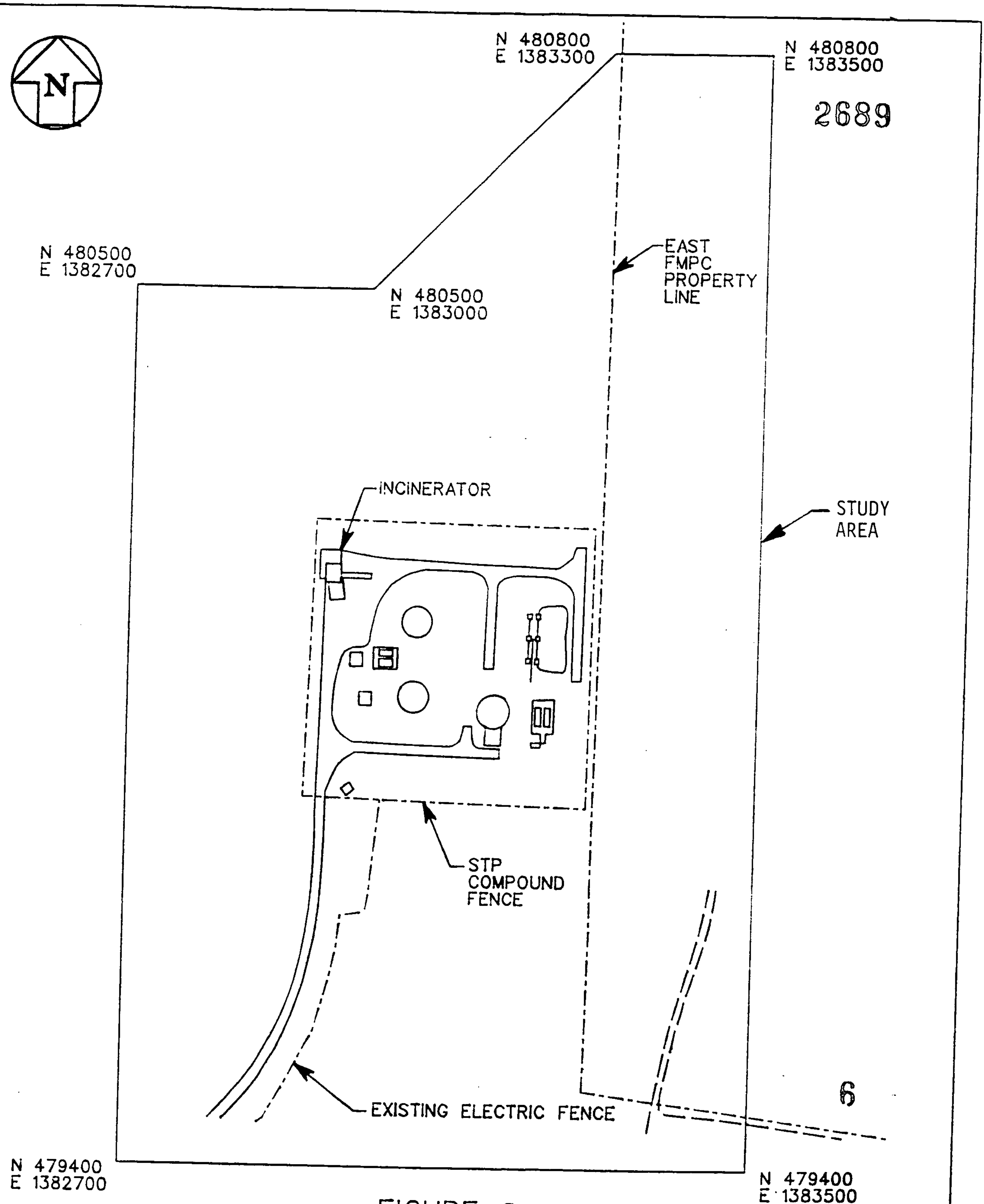


FIGURE 2

Executive Resource Associates, Inc.
A Technical Services Company

SUSPECT AREAS	
DRAWN BY: J. KING	047-1-0007
DATE: 8-8-91	

This work plan utilizes a three phase approach to execute the removal action. Phase I: layout the walkover and sample grid; perform a radiological walkover survey to highlight localized areas exceeding the field action level; excavate, containerize and sample the containerized soil exceeding the field action level; and grade and reseed the excavated areas. Phase II: perform post-excavation surface soil sampling activities. Phase III: revise the existing RSE based on post-excavation sampling results; and issue an addendum to the work plan outlining any further actions warranted in the study area. Sampling to be performed under this removal action includes: Toxicity Characteristic Leaching Procedure (TCLP), Hazardous Substance List (HSL) constituents and radiological parameters on the containerized material, and full HSL constituents, radiological parameters, and analysis for dioxins (on four samples) for the post-excavation sampling.

All project activities will be completed in accordance with the requirements defined in applicable Westinghouse Environmental Management Company of Ohio (WEMCO) procedures, in the NCP, CERCLA, pertinent DOE Orders, and the FEMP Quality Assurance Plan. Final remedial actions in the vicinity of the Sewage Treatment Plant will be conducted as part of Operable Units 3 and 5 (OU3 & OU5).

1.1 FERNALD SITE BACKGROUND

The FEMP is owned by the DOE and was operated from 1952 until 1989 for the processing of high purity uranium metal. In 1989 facility production operations were placed on standby to focus on environmental compliance related issues. The facility was formerly shutdown in 1991 after appropriate congressional notifications. Today, remaining workforces at the facility are focused solely on the implementation of environmental restoration related initiatives.

The facility is a 1,050 acre parcel located in southwestern Ohio. In November, 1989, the FEMP was placed on the CERCLA National Priorities List (NPL) as a result of concerns related to past and potential releases of hazardous substances to the environment. Consistent with Section 120 of CERCLA, the DOE and U.S.EPA jointly signed a Consent Agreement in March, 1990 establishing a schedule for the implementation of a sitewide RI/FS and a series of removal actions at the FEMP. This agreement was amended in September, 1991. This removal action work plan has been completed consistent with the terms of this Amended Consent Agreement.

Since October 1, 1990, responsibility for the FEMP has been administered through the Environmental Restoration and Waste Management Division of the DOE in order to better manage activities on the site.

1.2 BACKGROUND OF THE SEWAGE TREATMENT PLANT AREA

7

As previously discussed, the Sewage Treatment Plant Area is located on the eastern property line of the FEMP reservation. The Sewage

Treatment Plant, associated facilities and the abandoned incinerator are contained within a six foot chain link fenced area on FEMP property where access is restricted by security officers. The Sewage Treatment Plant became operational in 1952 for the treatment of FEMP sanitary wastewater. The system was later transitioned to receive both sanitary and process related wastewaters. The practice of employing the Sewage Treatment Plant to treat process related wastewater flows was discontinued recently with the installation and startup of biodenitrification effluent treatment system. Surface radiological measurements and limited soil samples collected in the vicinity of these facilities indicate the presence of localized elevated concentrations of radionuclides.

The solid waste incinerator is located in the northwest corner of the Sewage Treatment Area. This incinerator was operated from November 1954 through December 1979 at which time a new solid waste incinerator at Building 39 was put into service. The incinerator at the Sewage Treatment Plant was used to burn contaminated and uncontaminated combustible trash during its period of operation. Soil sampling results from the RI/FS indicate that radiological concentrations in the soils adjacent to the solid waste incinerator exceed those observed in prior routine environmental sampling conducted in 1984 and 1985 as part of the Environmental Monitoring Program. The concentrations of uranium-238 ranged from 1.8 to 25,670 pCi/g, in surface soil sampling results (see RI/FS data utilized in the RSE, Appendix I).

The abandoned solid waste incinerator is located within the fence around the Sewage Treatment Plant area, but the majority of the radiologically contaminated soil, as evidenced by the available data, is located outside the Sewage Treatment Plant's fenced boundary, adjacent to the incinerator. The area outside the fence has primarily been used for grazing cattle (under a lease agreement with the DOE). As a result of the RSE and the Action Memorandum, administrative control of some of the surrounding areas was established in December, 1990 with the transfer of all cattle grazing in the pasture areas directly north of the Sewage Treatment Plant area. In order to allow grazing in areas further north in the spring, when they would normally be returned to this area, livestock fencing was installed in April of 1991 to preclude access to areas adjacent to the incinerator. Based on RI/FS data, the new fence was installed approximately 680 feet north of the incinerator at the Sewage Treatment Plant.

The solid waste incinerator at the Sewage Treatment Plant has been identified as a suspect facility to be addressed under the RI/FS for OU3. The RI/FS for OU3, aimed at investigating the remedial alternatives in the Production Area and associated facilities, is presently underway. The soils in the vicinity of the structures at the Sewage Treatment Plant are within the scope of Operable Unit 5.

1.3 SUMMARY OF EXISTING DATA

Both the routine Environmental Monitoring Program (EMP) and the on-going RI/FS have shown evidence of radiological contamination in the vicinity of the Sewage Treatment Plant area. Once again, it is important to note that no analysis has been completed for the possible presence of non-radiological hazardous substances in the soils in the study area. This analysis is part of Phase II of this removal action.

The EMP contains data from surface soil sampling locations 3 and 11 (EMP-SS3 & EMP-SS11) and Air Monitoring Station No. 3 (AMS 3), all shown on Figure 1 of the RSE. The RSE includes data from this sampling program for the years 1984, 1985, and 1989. Historical air sampling data for 1989 from AMS 3, approximately 350 feet downwind (northeast) of the incinerator, show average radiological concentrations which lead to an inhalation dose estimate of less than one millirem (mrem) per year (see the RSE for further details).

The on-going RI/FS soil samples and sub-surface core samples collected in the vicinity of the solid waste incinerator at the Sewage Treatment Plant showed considerably higher radiological concentrations than previously observed under the EMP. The two highest surface soil radiological concentrations, closest to the incinerator, showed 25,670 pCi/g and 2,376 pCi/g of uranium-238. Figure 1 of the RSE shows sampling locations for the RI/FS data utilized for the RSE. The data from these sample points are listed in Table B.1 of the RSE (RI/FS Soil Sample Results). Table B.2 of the RSE includes additional RI/FS data obtained since the Action Memorandum was issued. None of this additional data exceeds any of the data utilized for the RSE. The highest soil radiological concentrations were in the vicinity of the incinerator toward the northeast; which is consistent with the predominant wind and emission direction.

In addition to surface soil samples, there were a limited number of core samples taken in this area as part of the RI/FS. These borings extended to a depth of 20 feet. The results from these samples are listed in Table 4 of the RSE and show only one sample exceeding the 100 pCi/g field action level at a depth of 1.5 - 3.0 feet. All of these sample points are within the Sewage Treatment Plant compound. There has been considerable disturbance within the compound and one can physically observe reasons for potential depth penetration. Since there have been little to no known disturbance of the soils outside the fenced area at the Sewage Treatment Plant, contamination is likely to be limited to surface soils resultant from air deposition from incinerator operation.

Radiological walkover surveys were performed as part of the RI/FS using 2"x2" NaI detectors (Eberline SPA-3). Appendix II is a map showing isopleths developed from this data. The higher radiological concentrations are found in the circular areas where the isopleths are close together. All of these areas of higher concentrations are within the FEMP site boundary.

1.4 NEED FOR A REMOVAL ACTION

Utilizing available data, three potential exposure pathways of radiological contamination to man were examined in the RSE: external exposure, inhalation, and milk ingestion. Other pathways were discounted in the RSE due to the relatively short durations of potential exposure until final remedial actions are implemented, and due to the existing access controls in place in the area.

Eight factors were considered in the assessment of the need for a removal action. These eight factors are listed in 40 CFR 300.415 (b)(2). The following factors apply specifically to the above background concentrations of contaminants occurring in the soils adjacent to the Sewage Treatment Plant area.

<u>40 CFR 300.415 (b)(2)(i)</u>

Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants.

Appropriate due to nearby resident farmer and nearby grazing cattle.

<u>40 CFR 300.415 (b)(2)(iv)</u>

High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface, that may pose a threat of release.

Appropriate based on radiological concentrations found in surface soil samples taken adjacent to the solid waste incinerator at the Sewage Treatment Plant.

<u>40 CFR 300.415 (b)(2)(v)</u>

Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released.

Appropriate based on radiological concentrations found in surface soil samples taken adjacent to the solid waste incinerator at the Sewage Treatment Plant and the possibility of significant weather events carrying the contaminants out of the study area in surface runoff.

1.5 OBJECTIVES OF THE REMOVAL ACTION

The objectives of the removal action are to reduce the potential for contaminant migration to previously uncontaminated areas, and minimize the potential for unacceptable exposures to human or environmental receptors until implementation of final remedial actions. Consistent with the NCP, the removal action shall contribute to the efficient performance of projected final remedial actions. The removal action shall be performed so as to minimize the potential for releases of hazardous substances incidental to removal field operations and in a cost efficient and safe manner consistent with site Standard Operating Procedures and worker health and safety requirements.

2.0 REMOVAL ACTION

This removal action is composed of three phases. Phase I: layout the walkover and sampling grid; perform a radiological walkover survey to highlight localized areas exceeding the field action level; excavate, containerize, and sample the containerized soil exceeding the field action level; and grade and reseed the excavated areas. Phase II: perform post-excavation sampling activities. Phase III: revise the existing RSE based on the post-excavation sampling results to evaluate the need for further action, and issue an addendum to the work plan outlining any further actions warranted in the study area.

After the grid is established, a surface radiological survey will be performed along the grid established across the study area (see Appendix III) both on and off FEMP property to identify localized areas exceeding the field action level. The radiological survey will be performed across the study area utilizing an unshielded 2"x2" NaI detector in a manner consistent with the protocols defined in the RI/FS Work Plan and Quality Assurance Project Plan. Areas exceeding the field action level will be temporarily marked for excavation.

In the absence of final remedial action goals, an interim field action level has been adopted for purposes of directing excavation activities. This field action level is being used to direct excavations to areas of highest radionuclide activity concentration which can be readily identified by hand held radiological instrumentation and immediately excavated. While it is recognized that detailed chemical data are not available, the DOE considers it prudent to proceed with the excavation of "hot spots" based on available radiological data. It is the intent of DOE to excavate and containerize soils from these localized "hot-spot" areas to allow progressive cleanup activities to proceed while pursuing detailed radiological and chemical sampling data from the study area.

The field action level to be utilized for this removal action has been derived from the use of the standardized risk equations presented in Chapter 4 of the Interim Risk Assessment Guidance For Superfund: Volume 1-Human Health Evaluation Manual Part B; December, 1991. For purposes of establishing this interim field action level, a commercial/industrial land use scenario has been adopted and Equation 13' employed from the above referenced guidance. Calculations will be made available to the U.S. EPA upon request. A target excess individual lifetime cancer risk of 1x10E-04 has been adopted to accommodate the projected short duration of potential exposure until final remedial action is implemented. The slope factors in the following table were employed to derive a soil concentration guideline for the project. The volatilization factor was set to zero. A natural isotropic distribution of the uranium isotopes was assumed.

SLOPE FACTOR TABLE

	FACTORS		
NUCLIDE	INHALATION	INGESTION	EXTERNAL
U-238	2.4E - 08	1.3E - 10	4.6E - 14
U-235	2.5E - 08	1.3E - 10	9.6E - 12
U-234	2.7E - 08	1.4E - 10	5.7E - 14

On this basis, an interim soil action level of 100 pCi/g of total uranium in soil has been established to direct excavation activities. This action level has been adopted pending receipt of detailed analytical data for any hazardous substances, revision of the RSE, and development of a position on the need for further field actions in the study area.

On the basis of past field experience gained in the RI/FS and on construction projects, it is considered highly probable that hand held radiological instrumentation can be approximately correlated to the 100 pCi/g total uranium soil guideline. While this correlation will be approximate due to many factors, including the mix of radionuclides present, detector efficiencies and detection geometries, it is considered a prudent course of action at this phase of the removal to direct excavations with real-time radiological measurements. Following identification of soils exceeding the threshold on the basis of the hand held radiological instrument, the excavation crew will be mobilized to remove and containerize soils exceeding this action level. Hand held radiological instrumentation will be employed to direct the excavation process and determine when soils exceeding the threshold have been successfully removed.

Excavations will proceed only on FEMP property. On the basis of existing data (see RSE), it is considered highly probable that no soils exceeding the 100 pCi/g action level will be identified within the surface soil of the vacant field adjacent to the Sewage Treatment Plant. In the event elevated activity concentrations are identified, the property owner will be notified and negotiations for a prudent course of action will be initiated with the owner. This course of action could range from simple notification or access controls to excavation activities. U.S. EPA and Ohio EPA will be notified in this event and consulted on the appropriate course of action prior to implementation. Additional discussion on the excavation process can be found in Section 2.1.

Following excavation, representative soil samples will be collected from the study area to determine the concentrations of radiological and chemical constituents present in the surface soils in the study area. Soil samples will be collected consistent with the RI/FS Work Plan and QAPP protocols. Soil sampling is further discussed in Section 2.2. Following collection of soil samples, the excavated areas will be re-seeded. On the basis of the analytical results, the RSE will be revised to examine the need for further action. To support this determination, a pathways analysis will be performed assuming a limited period of exposure (approximate 10 years), a commercial/industrial exposure scenario for on property soils and a residential exposure scenario for off-property soils. Based upon the findings of the revised RSE, a work plan addendum will be submitted proposing the need, if any, for additional field actions.

2.1 PHASE I

The first field activity of the removal action is the layout of the walkover survey and post-excavation sampling grid. The grid will be established within the confines of the study area outlined on the Figure in Appendix III and will be consistent with the RI/FS work plan. The grid locations were chosen based upon existing walkover and soil sample data (Appendix II and RSE). The specific coordinates of the sampling points are not provided since the potential for obstacles in the field exists. The grid will be laid out in accordance with the map provided in Appendix III. The grid will be tied to the existing site coordinate system being utilized for the AutoCAD base map for the RI/FS.

As previously discussed, a radiological survey will be performed on the study area employing an unshielded 2"x2" NaI detector and the protocols defined in the RI/FS Work Plan and QAPP. On the basis of site experience and field measurements, a correlation will be established to permit the real-time approximation of soils exhibiting greater than 100 pCi/g of total uranium. These areas will be marked for excavation.

As the walkover survey progresses, any area on-site found to exceed 100 pCi/g will be marked for excavation. After these areas have been marked, excavation can begin and will continue until in-situ soil concentrations are below the field action level as determined by direct radiological measurement using a hand held instrument. It is recommended that a measurement be taken approximately every 6" of excavation in the marked area. Based on existing soil sample data, it is estimated that an average of 6"-12" will need to be excavated. Because of these shallow excavations, this activity can be performed by hand. If any of the excavations pose a safety threat temporary access controls, such as fencing or roping, may be installed. During excavation activities, logs including maps will be developed to record excavated areas.

As previously stated, this action level will approximate 100 pCi/g of total uranium in soil assuming a natural isotropic activity distribution. A hand held organic vapor analyzer will also be used during excavation in support of worker health and safety. In the event that above background levels are encountered, affected soils will be excavated.

Excavated soil will be containerized and representative samples will be collected from the containers for purposes of determining the radiological properties of the soil and to complete a hazardous waste determination. Containerized soil will be transferred to a storage area within the FEMP former production area. Upon receipt of analytical results, a hazardous waste determination will be completed. In the event the soil is determined to be hazardous pursuant to 40 CFR 262.11, the containers will be transferred to onsite hazardous waste storage facilities. Upon approval of the work plan for Removal Action No.17- Improved Storage of Soil and Debris by U.S. EPA, management of the excavated soils will be transitioned to be consistent with the requirements of this approved plan.

After excavation activities have been completed, excavated areas will be graded and reseeded. If it is determined that any of the excavations pose a safety hazard, they will be backfilled and temporary access controls will be left in place until excavation is filled. If fill material is required, it will be obtained from an off-site independent source. If any excavations pose a safety threat, temporary access controls will be left in place until fill material is placed. After fill is placed, the area will be graded and reseeded.

2.2 PHASE II

After excavation activities are complete, surface soil samples will be taken at the 40 locations shown in Appendix III. Soil samples will be collected from a depth of zero to six inches. Thirty soil sample locations will be analyzed for the following radiological parameters: uranium-234, uranium-235, uranium-238, radium-226, radium-228, thorium-228, thorium-230, and thorium-232. The remaining 10 surface soil sample locations will be analyzed for the previously listed radiological parameters, full HSL constituents, and four samples immediately adjacent to the incinerator will be analyzed for dioxins, 2, 3, 7, 8-TCDD/TCDF, and PCDD/PCDF. All samples will be collected, documented, packaged, shipped and analyzed in accordance with the RI/FS Work Plan. All samples will be analyzed at a laboratory approved for use on the RI/FS and all data collected will be made available to on-going RI/FS activities. Final sample locations will be surveyed and tied into the state planar coordinate system.

2.3 PHASE III

Once results from the containerized and surface soil sampling activities are available, the RSE will be revised to incorporate all sampling results, including non-radiological parameters. Based on the results of the revised RSE, an addendum to this work plan will be submitted defining the need, if any, for additional actions to address the soils in the Sewage Treatment Plant Area.

3.0 PROGRAM MANAGEMENT

The following activities will be undertaken to provide planning and management for the removal action.

3.1 RESPONSIBILITIES

The DOE is the lead agency for this removal action and will coordinate the execution of this removal action. As stated in the Amended Consent Agreement under CERCLA 120 and 106(a), if the DOE determines under Section 104 that any activities or work being implemented under this Amended Consent Agreement may create an imminent threat to human health or the environment from the release or threat of release of hazardous substance, pollutant, contaminant, or hazardous constituent, it may stop any work or activities for such period of time as needed to respond and take whatever action is necessary to abate the danger. Reporting to the U.S. EPA will be in accordance with Section XXIII of the Amended Consent Agreement.

U.S. EPA shall review, comment and approve the work plan and follow progress through meetings/site visits and the Amended Consent Agreement progress reports.

WEMCO, the Maintenance and Operations Contractor at the FEMP, will coordinate, manage, implement, monitor activities and prepare all reports associated with the removal action in a manner consistent with the DOE and regulatory requirements and guidance.

This removal action shall be managed by the WEMCO/DOE OU3 team to ensure compatibility with the final remedial action(s) selected for OU3 and OU5. Data and results from this removal action will be used to evaluate the final remedial options for OU3 and OU5.

Ohio EPA, while not a signature to the Amended Consent Agreement, maintains a significant role in the successful implementation of removal actions at FEMP. Ohio EPA shall review and comment on the work plan and follow progress through meetings/site visits and the Amended Consent Agreement progress reports.

All personnel directly involved in the planning and implementation of this removal action will be trained in accordance with 29 CFR 1910.120, the standard operating procedures for the work involved, and with the requirements of the approved work plan.

3.2 SCHEDULES

A proposed schedule has been developed and key milestones of this schedule are given in Table 4-1.

Table 4-1 - Key Milestones of Proposed Project Schedule

	Duration (months)	Accumulated Duration* (months)
Complete Phase I	3	3
Complete Phase II	8	11
Complete Phase III	3	14

*From Approval of Work Plan By U.S. EPA

4.0 QUALITY ASSURANCE PLAN

This removal action will be conducted in accordance with the overall quality assurance program at the FEMP as described in the site Quality Assurance Plan. The Quality Assurance Plan is based on the criteria specified in ASME NQA-1, Federal EPA Guideline QAMS-005/80 and DOE Orders 5700.6 and 5400.1. Detailed requirements are implemented by the WEMCO Site Policies and Procedures Manual, FMPC-2054, by WEMCO Departmental procedures, and Topical Manuals. Sample and analysis activities will be conducted consistent with the RI/FS QAPP. The U.S. EPA is in the process of reviewing a draft Sitewide Quality Assurance Project Plan (QAPjP) covering all sitewide sampling and analysis activities. Upon approval, remaining sampling and analysis activities will be conducted consistent with the Sitewide QAPP.

5.0 HEALTH AND SAFETY PLAN

The removal action will be conducted in accordance with the provisions of the FEMP site-wide health and safety program (WMCO June 1990). Consistent with this program and 29 CFR 1910.120, a task specific health and safety plan will be prepared addressing the proposed work activities. The task specific Health and Safety Plan is currently in draft and will be revised to incorporate any changes resulting from the final approval of the work plan. A copy of the Health and Safety Plan will be finalized prior to field mobilization and will be made available to U.S. EPA upon request at that time. The Health and Safety Plan identifies, evaluates, and controls all safety and health hazards associated with this removal action. In addition, it provides for emergency response for hazardous operations.

APPENDIX I

REMOVAL SITE EVALUATION

Contaminated Soils Adjacent to Solid Waste Incinerator

at the Sewage Treatment Plant

Feed Materials Production Center
U. S. Department of Energy

October 1990

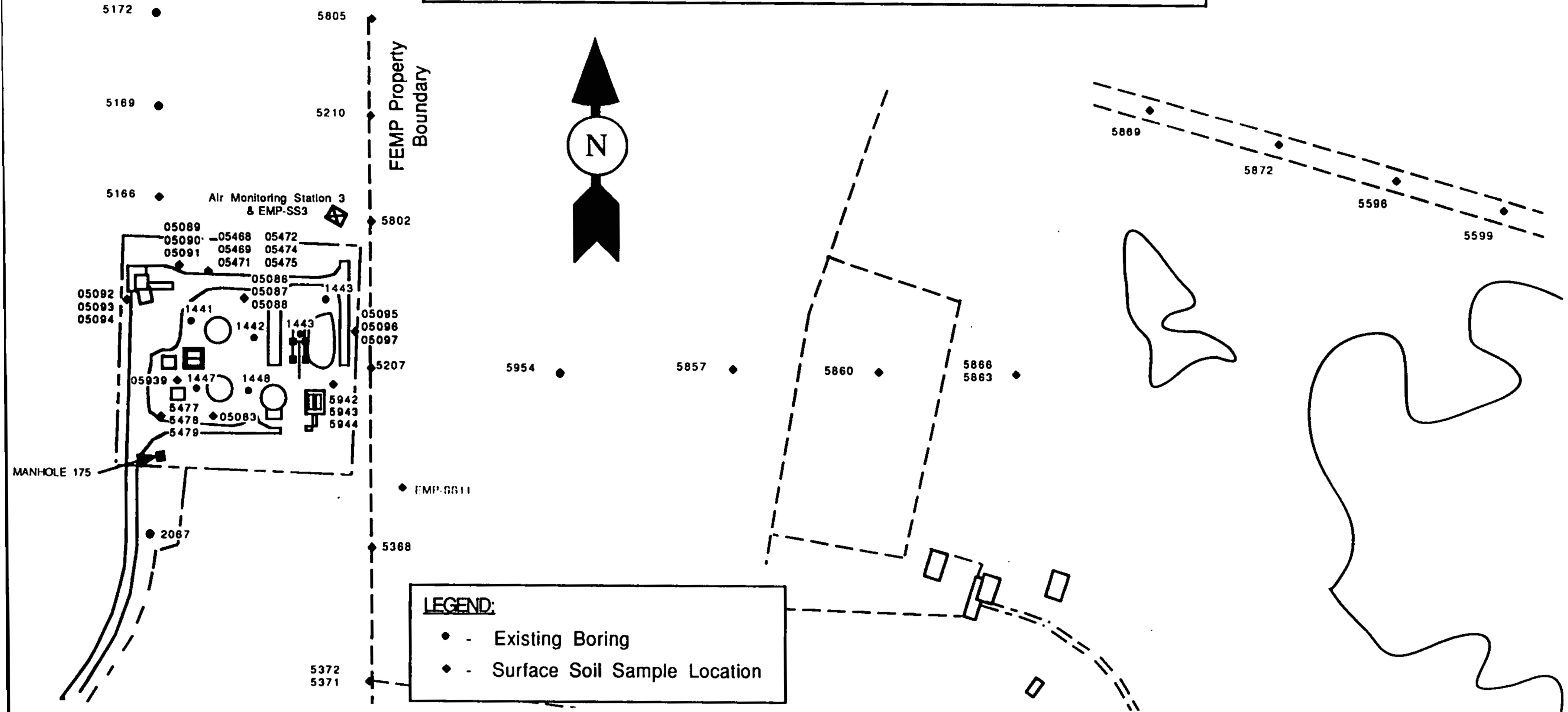
TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
2.0	SOURCE TERM	1
	2.1 Environmental Soil Sampling Data	1
	2.2 Environmental Air Sampling Data	2
	2.3 RI/FS Soil and Core Sampling Data	3
	2.4 Pathway Assessment	5
3.0	EVALUATION OF POTENTIAL THREAT	5
4.0	ASSESSMENT OF THE NEED FOR REMOVAL ACTION	7
5.0	APPROPRIATENESS OF A RESPONSE	7
APPENDIX A		9
APPENDIX B		10
APPENDIX C		11
REFERENCES		12
FIGURE 1		

LIST OF TABLES

		Page
Table 1 -	Historical Uranium-238 Soil Concentrations in the Incinerator Area	2
Table 2 -	Annual Average Airborne Uranium at Station BS-3	2
Table 3 -	Average Soil Concentrations for 12 RI/FS Samples Exceeding Background Concentrations	4
Table 4 -	Uranium-238 in Soil Core Samples	5
Table 5 -	Average Soil Concentrations Compared to NRC Guidance	6

FIGURE 1: SOIL SAMPLE LOCATIONS



21

2689

1.0 INTRODUCTION

The solid waste incinerator is located in the northwest corner of the sewage treatment plant area at the Fernald Environmental Management Project (FEMP). This incinerator was operated from November of 1954 through December of 1979 at which time a new solid waste incinerator at Building 39 was placed into service. The incinerator at the sewage treatment plant was used to burn contaminated and uncontaminated burnable trash during its period of operation. Soil sampling results from the Remedial Investigation and Feasibility Study (RI/FS) indicate that concentrations of radionuclides in the soils adjacent to the solid waste incinerator are above background levels and exceed those observed in prior routine environmental sampling. The solid waste incinerator is located within the fenced area of the sewage treatment plant but the majority of the area with contaminated soils is located outside the sewage treatment plant's fenced boundary. The area outside the fence is primarily used for grazing dairy cattle (under a lease agreement with the DOE) owned by a neighboring farmer. Access to the sewage treatment plant is controlled by WEMCO personnel, however access for the grazing dairy cattle to the areas adjacent to the incinerator is uncontrolled. The solid waste incinerator at the sewage treatment plant has been identified as a "suspect area" to be addressed under the RI/FS Operable Unit 3. The RI/FS for Operable Unit 3, aimed at investigating the remedial alternatives in the Production Area and other identified suspect areas outside the Production Area, is presently underway.

This Removal Site Evaluation (RSE) has been completed by the DOE under authorities delegated by Executive Order 12580 under Section 104 of CERCLA and is consistent with Section 300.410 of the National Oil and Hazardous Substance Pollution Contingency Plan (NCP). This RSE addresses contaminated soils adjacent to the solid waste incinerator at the sewage treatment plant and has been completed to support the decision as to whether the present conditions warrant a removal action.

2.0 SOURCE TERM

Both the routine Environmental Monitoring Program (EMP) and the on-going Remedial Investigation/Feasibility Study (RI/FS) have shown evidence of contamination in the vicinity of the incinerator. It is possible that there was some contribution from other facilities at FMPC, but it is likely that most, if not all, of the activity is due to incinerator effluent.

2.1 Environmental Soil Sampling Data

There have been two environmental soil sampling locations in the area that are routinely monitored through the EMP. Sampling Point No. 3 is adjacent to the incinerator and on-site. Sampling Point No. 11 is nearby but off-site (see Figure 1). The U-238 soil concentrations from the 1984[1] and 1985[2] and 1989[3] environmental monitoring were:

Table 1. Historical Uranium-238 (pCi/g) Soil Concentrations
Incinerator Area

	No. 3	No. 11
1984 (Aug.)	68.5 ± 3.5 (2σ)	13.8 ± 0.7 (2σ)
(Dec.)	39.9 ± 1.7	19.3 ± 0.8
1984 (Resample)	2.8 ± 0.1	10.8 ± 0.5
1985	35.9 ± 14.5	14.2 ± 0.7
1989 0-5 cm	79 ± 13	Discontinued
5-10 cm	58 ± 9	Discontinued

These analyses were for elemental uranium, so the amounts of U-235 and U-234 present were not known. Subsequent RI/FS analyses showed the average activity ratios for typical soils with this range of uranium concentration to be

U-238 : U-235 : U-234
1.00 : 0.07 : 0.48

These ratios indicate a mixture of depleted and normal uranium. Very low concentrations of U-234 daughters indicate that this is not natural uranium. By 1984, the incinerator had not been used for five years.

2.2 Environmental Air Sampling Data

The nearest EMP environmental air sampling location (BS 3 and later AMS 3) east-northeast of the incinerator (see Figure 1) showed the highest concentrations among the FEMP-wide air sampling network. The source is likely to be a combination of entrained contaminated soil and effluent from other FEMP facilities. Airborne uranium concentrations for that air sampling location are summarized below

Table 2. Annual Average Airborne Uranium at BS 3 (AMS 3) (pCi/m^3)

	Average of Weekly Samples		Composite Analysis		
	U-238	U-234	U-235	U-238	Th-230
1984	1.36E-02				2.61E-04
1985	5.57E-03				7.64E-04
1988	3.59E-03				----
1989	7.1 E-04	2.0E-04	1.3E-05	3.6E-04	<1.1E-05

The committed effective dose equivalent from these concentrations is considerably less than the 10 mRem/yr NESHAPS criteria even with 100 percent occupancy. There are no residents at this location.

Annual composite sample analyses, for a number of radionuclides, showed either very low airborne concentrations or very low inhalation dose commitments relative to the uranium concentrations. Radionuclides that were identified included

Sr-90	U-236
Tc-99	Np-237
Ra-228	Pu-238
Th-228	Pu-239,40
Th-230	Pu-241
Th-232	Pu-242

No measurable radium-226 was noted at this air sampling location. A more complete summary of air sampling data is in Appendix A.

Exposure rates measured by environmental dosimeters, at the air sampling location, are not statistically different from the ambient background.

2.3 RI/FS Soil and Core Sampling Data

During the on-going RI/FS, soil samples and sub-surface core samples collected in this vicinity showed considerably higher concentrations than previously observed. Twelve of 24 samples were above background and six of these 12 exceeded guidance for unrestricted use[4]. The two highest samples, closest to the incinerator, showed 25,670 pCi/g and 2376 pCi/g of uranium-238. Figure 1 shows the sampling locations and Appendix B summarizes the radionuclide concentrations.

From inspection of the data, there are two distinct concentration distributions. The lower group remained below 10 pCi/g. This group included samples:

5368	5857
5371	5860
5372	5863
5596	5866
5599	5869
5854	5872

The U-238 concentration among these samples averaged:

$$5.1 \pm 2.7 \text{ pCi/g } (1\sigma)$$

On that basis, one can be 99.7 percent confident that concentrations exceeding 13.2 pCi/g (average plus 3σ) are above background. The 12 remaining samples exceeded that concentration.

Inspection of data for the 12 background samples showed that all other radionuclide analyses, in addition to uranium, yielded results at expected ambient background concentrations or near the analytical sensitivity. These 12 background soils were all at the greatest distances and/or not downwind compared to average meteorological conditions.

Highest soil concentrations were in the immediate vicinity of the incinerator and the apparent plume extended toward the northeast which is the most probable wind direction.

In order to assess the potential impacts, an average concentration of the various radionuclides was established for the 12 samples exceeding background.

Table 3. Average Soil Concentrations for 12 Samples Exceeding Background

Isotope	Detected in % of Samples	Average Concentration (pCi/g)	Range (pCi/g)
U-238	12/12	2391 ± 7361	13.6 - 25,670
U-235	11/11	172 ± 518	0.8 - 1730
U-234	11/11	1151 ± 3272	12.8 - 10,977
Ra-226	11/11	7.7 ± 17.2	0.9 - 57.4
Th-230	11/11	17.4 ± 33.5	1.8 - 102
Ra-228	10/11	2.9 ± 3.5	< 1.8 - 12.2
Th-228	11/11	2.7 ± 2.8	1.0 - 10.2
Th-232	11/11	2.9 ± 3.3	0.7 - 11.3
Tc-99	4/11	4.6 ± 6.6	< 0.9 - 14.4
Pu-239,40	1/11	1.1 (single value)	< 0.6 - 1.1
Sr-90	6/11	1.3 ± 0.7	< 0.5 - 2.3

The selected 12 samples were based upon elevated uranium concentrations. Many of the other radionuclide concentrations in those samples appeared to be at background levels but they were, none-the-less, included to create the average values above. A number of samples showed unique features. Sample 5095 had the highest radium-226 concentration (57.4 ± 1.2 pCi/g) which was also high when compared to uranium concentrations in that sample. In any case, no allowance or subtraction was made for background in the average concentrations given in Table 3. Note that there is a relatively large standard deviation associated with the averages. For uranium, the standard deviation gives roughly plus or minus 300 percent.

Data from a limited number of core samples from this area, down to twenty feet, suggest that contaminant particle sizes are small enough (or soluble enough) to penetrate into soil (e.g. gravel and sand). This will affect any decision to physically move the contaminated soil zones.

As part of the RI/FS, a limited set of data are available from core samples collected in this area. Sample locations 1441, 1442, 1447, and 1448 are in the central area within the fenced compound which includes the incinerator and the sewage treatment plant. They are approximately 100-300 ft from the incinerator. Location 1444 is farther east (approximately 350 ft from the incinerator) and 1443 is approximately 400 ft due east of the incinerator (see Figure 1). The profiles are shown in Table 4.

Table 4. Uranium-238 in Soil Core Samples (pCi/g)

Depth (ft)	1441	1442	1443	1444	1447	1448
(0 - 1.5)	58.3	42.1	45.6	12.9	19.9	41.9
(1.5-3.0)	6.67	6.14	11.9	224.4		3.9
(3.0-5.5)	15.3	4.60	33.0	69.6	4.9	
(5.5-10)					1.7	4.7
(10-15)	13.8		35.4	4.7 (2.3)		5.7 (2.0)
(15-20)	2.53		25.3			

Note: Parenthetical values are for second samples at same location

Relative to potential excavation, these data suggest that no removal is required in some areas. Other areas may require that a one foot layer be removed, but some removal beyond a three foot depth may be necessary.

Additional RI/FS sample results were obtained after calculations for this RSE were performed. These results are included in Appendix B in Table B.2. It is important to remember this data is included for informational purposes and wasn't used in the calculations of this RSE. These sample points are also shown on Figure 1.

2.4 Pathway Assessment

Because the contributing effluent is believed to be incinerator ash particles (and condensate nuclei) it is probable that the particle matrix containing the radionuclides is relatively insoluble. Leaching to subsurface water, and root uptake by vegetation, can be expected to be relatively low and slow. Inhaled particulate and deposition in bovine nasal turbinates should result in minimal transfer to the bloodstream and to other organs and milk. The fraction deposited in the lower respiratory system will depend upon the airborne particle size distribution. That fraction in the deep lung will be slowly cleared with longer term cumulative radiation dose to the lung and to the tracheobronchial lymph nodes.

Although RESRAD[6] transfer parameters are used later for dose estimates, cow soil ingestion should result in very little G.I. absorption. Similarly low vegetation (forage) root uptake is expected but RESRAD values are used.

3.0 EVALUATION OF THE MAGNITUDE OF THE POTENTIAL THREAT

The available data permits only a conservative assessment, that appears adequate to justify consideration of removal action(s). Several comparisons can be made by focusing on the RI/FS soil sample data. The net average concentration has been developed for the radionuclides in 12 soil samples. This is conservative since 50 percent of those samples were below cleanup guidance concentrations[4]. Other RI/FS samples from within the incinerator compound, and also those from the FMPC EMP, show considerably lower concentrations. More data will be required to characterize the magnitude and extent of the contamination.

One comparison is afforded by comparison to concentrations recommended for unrestricted use in the NRC Branch Technical Position[4]. These comparisons are summarized below.

Table 5. Average Soil Concentration Compared to NRC Guidance

Table 3 Averages		Guidance Concentration	
Th-232	2.9 pCi/g	10 pCi/g	Th-232 + daughters
Th-228	2.7		
Ra-228	2.9		
U-238	2391 pCi/g	35 pCi/g	Depleted U
U-238	2391 pCi/g	30 pCi/g	Enriched U
U-235	172		
U-234	1151		

As previously described, uranium isotopes most commonly exceed the cleanup criteria. Some locations have unique radionuclide mixtures. For example sample locations 5092 and 5095 have radium-226 concentrations which exceed the 5 pCi/g limit provided in 40 CFR 192[5] for uranium mill tailings sites. The FEMP is not a mill tailings site and current data do not permit averaging over 100m^2 for better comparison to 40CFR192.

Another comparison can be made through analyses for dose estimates and the associated risk. Appendix C shows the derivation of these estimates. The preponderance of the radiation doses accrue through:

External exposure	3.8 mRem/yr
Inhalation	4.7 mRem/yr
Milk ingestion	7.6 mRem/yr

These are modeled to human (not bovine) exposure (see Appendix C for model assumptions). The farmer visits the area for approximately one hour per week. A fraction of the dairy herd typically occupies the area about 10 hours per week, although calculations for the milk pathway assumed 100 percent occupancy.

No water pathways were analyzed since the scope of this evaluation is for the short term and also because geological characteristics are unknown.

The milk pathway is also analyzed in Appendix C however the potential contribution by that path was relatively low (7.6 mRem/yr) and a number of conservative assumptions were made. A fraction of the dairy herd ingests only a fraction of their total forage from the contaminated area. Through the routine EMP, monthly samples of milk production from Knollman's Dairy (adjacent to the FEMP) have only rarely shown concentrations in excess of the detection limit of 0.7 pCi/L. One outstanding analysis in 1989 showed 12.8 pCi/L[3]; one milk sample showed 1.35 pCi/L in 1983 and another showed 1.0 pci/l in 1988. These concentrations can be compared to the conservative model which yielded 198 pCi/L of U-238 and 95.7 pCi/L of U-234. Recent conversation with the farmer indicates that most of the cows grazing this area are not milkers.

By adding effective dose equivalents and committed effective dose equivalents (to simplify this assessment), the total estimated annual dose equivalent is 16.1 mRem. Using the EPA risk estimate of 2×10^{-4} per person - Rem effective dose, the associated risk for a fatal cancer is

$$0.016 \text{ Rem} \times (2 \times 10^{-4}) = 3.2 \times 10^{-6}/\text{yr}$$

The risk for a fatal cancer for a 70 year lifetime estimate is less than 2.2×10^{-4} because weathering will reduce the available quantities of the radionuclides.

The dose estimate of 4.7 mRem/yr due to inhalation can be compared to the EPA NESHAPS limit of 10 mRem/yr (40 CFR 61.92). The milk ingestion estimated dose of 7.6 mRem/yr could be compared to the EPA limit of 4 mRem/yr (40 CFR 141.15) through drinking water. The total of 16 mRem/yr does not exceed DOE guidance of 100 mRem/yr in DOE Order 5400.5.

4.0 ASSESSMENT OF THE NEED FOR REMOVAL ACTION

Consistent with Section 40 CFR 300.410 of the National Contingency Plan, the Department of Energy (DOE) shall determine the appropriateness of a removal action. Eight factors to be considered in this determination are listed in 40 CFR 300.415 (b)(2). The following apply specifically to the above background concentrations of contaminants occurring in the soils adjacent to the solid waste incinerator at the sewage treatment plant.

40 CFR 300.415 (b)(2)(i)

Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants.

40 CFR 300.415 (b)(2)(iv)

High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface, that may pose a threat of release.

40 CFR 300.415 (b)(2)(v)

Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released.

These factors are considered appropriate as a result of the concentrations of contaminants in the soils adjacent to the solid waste incinerator at the sewage treatment plant. Livestock grazing or significant storm events have a potential to cause these concentrations to migrate or be carried to areas which are uncontaminated.

5.0 APPROPRIATENESS OF A RESPONSE

If it is determined that a response action is appropriate due to both the level of contamination found in the soils adjacent to the solid waste incinerator at the sewage treatment plant and the potential of contaminant migration, a removal action may be required to address the existing situation.

If a planning period of less than six months exists prior to initiation of a response action, DOE will issue an Action Memorandum. The Action Memorandum will describe the selected response and provide supporting documentation for the decision.

If it is determined that there is a planning period greater than six months before a response is initiated, DOE will issue an Engineering Evaluation/Cost Analysis (EE/CA) Approval Memorandum. This memorandum is to be used to document the threat of public health and the environment and to evaluate viable alternative response actions. It will also serve as a decision document to be included in the Administrative Record.

Table A.1
Annual Average Airborne Radionuclide Concentrations at BS 3 (AMS 3)[1]
Composite Sample Analyses (pCi/m^3)

Radionuclide	1984	1985	1989
Sr-90	[3]	2.61 ± 0.65E-04	
Tc-99		6.38 ± 0.80E-03	1.60 ± 1.10E-04
Ra-226		<5.2E-05	<5.3E-07
Ra-228		3.91 ± 3.91E-05	<1.1E-05
Th-228	5.06 ± 0.24E-05	2.61 ± 0.52E-05	<1.1E-05
Th-230	7.46 ± 0.12E-04 (2.61E-04)[2]	2.61 ± 0.52E-04 (7.64E-04)[2]	<1.1E-05
Th-232	2.77 ± 0.24E-05	1.44 ± 0.26E-05	<1.1E-05
Np-237	1.07 ± 0.06E-05	<1.3E-06	
Pu-238	2.65 ± 0.7E-06	2.0 ± 0.8E-06	3.0 ± 2.1E-06
Pu-239,240	5.54 ± 0.6E-05	1.25 ± 0.2E-05	4.9 ± 0.03E-07
Pu-240			1.3 ± 0.01E-07
Pu-241		6.06 ± 0.16E-05	2.0 ± 0.06E-06
Pu-242			7.1 ± 0.2E-05
U-234			2.0 ± 0.7E-04
U-235			1.3 ± 0.04E-05
U-236			8.4 ± 1.3E-06
U-238	1.36 ± 1.30E-02	5.57E-03	3.60 ± 0.01E-04 (7.1E-04)[2]
Gross Beta	6.38 ± 1.28E-02	2.64 ± 1.13E-02	2.65E-02

(1) Designation of BS 3 was changed to AMS 3 at reorganization of the Air Sampling Network.

(2) Parenthetical concentrations represent averages of individual analyses during that year.

(3) Blank fields indicated that the specific analysis was not performed.

APPENDIX B

Table B.1
RI/FS Soil Sample Results (pCi/g)

Sample Number	U-238	U-235	U-234	Ra-226	Th-230	Ra-228	Th-228	Th-232
5083	13.6±2.7			*				
5086	259±18	16.4±2.4	341±27	1.8±0.3	3.9±0.8	2.5±0.5	1.8±0.5	2.3±0.6
5089	2376±114	123±8	1010±60	5.52±0.51	31.4±4.8	5.13±0.85	3.6±0.8	3.8±0.8
5092	25670±1281	1730±87	10977±549	19.4±	58.9±8.7	12.2±2.6	10.2±1.7	11.3±1.9
5095	187±13	13.4±2.3	165±12	57.4±1.2	102±15	<1.8	5.1±1.0	6.6±1.3
5166	51.0±8.1	4.5±1.0	50.4±8.0	1.3±0.2	2.8±0.7	1.3±0.3	1.6±0.4	1.5±0.4
5169	16.7±2.9	0.9±0.4	16.7±2.9	1.1±0.1	3.0±0.7	1.3±0.3	1.4±0.4	1.2±0.4
5172	16.5±2.7	0.8±0.3	15.5±2.5	1.2±0.2	2.2±0.6	1.3±0.3	1.4±0.4	1.3±0.4
5207	13.5±2.1	0.8±0.3	12.8±2.1	2.5±0.4	6.5±1.2	1.2±0.3	1.0±0.3	1.1±0.3
5210	46.3±6.6	3.6±0.8	34.8±5.0	0.9±0.1	1.8±0.6	1.6±0.3	1.0±0.4	0.7±0.3
5368	4.4±0.6	0.7±0.2	4.4±0.6	1.1±0.2	2.6±0.4	0.8±0.2	1.6±0.3	1.3±0.3
5371	4.2±0.6	<0.6	3.8±0.5	0.9±0.1	1.9±0.3	0.8±0.2	1.1±0.2	1.2±0.2
5372	9.6±1.4	<0.6	8.4±1.2	0.9±0.1	2.2±0.4	<0.7	1.4±0.3	1.2±0.2
5596	2.2±0.4	<0.6	2.2±0.4		*			
5599	2.3±0.4	<0.6	2.0±0.4					
5802	21.6±2.7	1.0±0.2	19.0±2.4	1.2±0.4	3.0±0.4	1.1±0.2	1.2±0.2	1.1±0.2
5805	23.5±2.9	1.4±0.3	22.9±2.8	0.9±0.1	3.0±1.5	1.1±0.2	1.8±1.1	1.2±0.9

* Blank fields indicate data was not available.

Table B.1 (Cont.)
RI/FS Soil Sample Results (pCi/g)

Sample Number	U-238	U-235	U-234
5854	5.0±0.7	<0.6	4.6±0.6
5857	7.2±1.0		*
5860	4.0±0.7	<0.6	3.5±0.6
5863	9.2±1.6	1.3±0.4	8.9±1.5
5866	7.8±1.2	0.6±0.2	7.3±1.2
5869	3.2±0.6	<0.6	3.0±0.6
5872	1.8±0.3	<0.6	1.6±0.3

* Blank fields indicates that data was not available.

Table B.1 (Cont.)
RI/FS Soil Sample Results (pCi/g)

Sample Number	Tc-99	Pu-239,40	Sr-90
5083			
5086	<9	<0.6	<0.5
5089	<9	<0.6	0.8±0.2
5092	14.4±1.8	1.1±0.4	1.9±0.3
5095	<9	<0.6	<0.5
5166	<2.8	<0.6	<0.5
5169	<2.5	<0.6	0.8±0.2
5172	<2.8	<0.6	0.6±0.2
5207	2.1±1.0	<0.6	<0.5
5210	<9	<0.6	1.6±0.3
5368	<0.9	<0.6	<0.5
5371	<0.9	<0.6	<0.5
5372	<0.9	<0.6	<0.5
5596		*	
5599			
5802	1.0±0.4	<0.6	<0.5
5805	0.9±0.4	<0.6	2.3±0.4

* Blank fields indicate that data was not available.

2689

Table B.2
RI/FS Surface Soil Sample Results (pCi/g)

Data presented by sample number and depth in inches. NA indicates not analyzed; a number preceded by a "less than" (<) symbol indicates that the compound was not present above the detection limit of the analytical instrument.

Radiological Parameters	05087 2 - 4	05088 4 - 7	05090 2 - 4	05091 4 - 6	05093 2 - 4	05094 4 - 6	05096 2 - 4	05097 4 - 6
Cs-137	1.1	0.4	0.7	0.3	0.6	<0.4	<0.6	<0.4
Pu-238	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
Pu-239/240	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
Ra-226	1.6	1.4	6.4	1.9	<1.3	2.1	188.0	67.0
Ra-228	2.2	1.7	3.9	1.9	5.7	6.9	<2.6	<1.7
Sr-90	1.8	0.8	0.5	1.0	1.2	0.7	0.6	<0.5
Tc-99	1.0	<0.9	4.3	2.0	12.8	6.1	<0.9	<0.9
Th-228	2.0	1.4	3.3	1.5	10.2	3.4	1.3	1.3
Th-230	7.7	4.9	28.7	7.0	50.5	8.3	325.0	87.0
Th-232	2.2	1.4	3.9	1.4	14.0	4.8	2.2	1.5
U-234	228.0	116.0	2913.0	543.0	7591.0	2160.0	312.0	98.0
U-235/236	15.4	6.9	98.0	26.4	372.0	82.0	14.9	3.5
U-238	186.0	98.0	3100.0	560.0	7771.0	2006.0	328.0	101.0

2689

Table B.2 (cont.)
RI/FS Surface Soil Sample Results (pCi/g)

Data presented by sample number and depth in inches. NA indicates not analyzed; a number preceded by a "less than" (<) symbol indicates that the compound was not present above the detection limit of the analytical instrument.

Radiological Parameters	05468 0 - 6	05469 (dup.)	05471 6 - 12	05472 (dup)	05474 12 -18	05475 (dup)	05477 0 - 6	05478 6 -12
Cs-137	0.3	0.3	0.3	0.2	0.3	<0.2	0.7	<0.2
Pu-238	1.4	1.5	2.4	<0.6	<0.6	1.7	<0.6	<0.6
Pu-239/240	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	1.5	<0.6
Ra-226	4.9	4.3	3.0	2.7	1.4	3.4	2.4	2.1
Ra-228	18.0	16.9	8.5	7.2	1.2	4.3	1.0	0.8
Sr-90	1.8	1.4	0.7	<0.5	0.7	1.2	0.6	<0.5
Tc-99	13.0	9.1	7.4	4.3	1.2	4.4	228.0	56.9
Th-228	17.6	24.8	8.2	5.7	2.0	6.4	1.1	1.3
Th-230	755.0	806.0	460.0	359.0	11.3	385.0	8.2	5.2
Th-232	30.8	61.9	12.0	6.1	1.8	7.8	2.9	0.9
U-234	1644.0	1110.0	960.0	602.0	345.0	660.0	1627.0	808.0
U-235/236	134.0	95.3	54.9	37.8	17.6	38.6	143.0	41.5
U-238	1941.0	1445.0	1124.0	771.0	389.0	720.0	1477.0	790.0

2689

Table B.2 (cont.)
RI/FS Surface Soil Sample Results (pCi/g)

Data presented by sample number and depth in inches. NA indicates not analyzed; a number preceded by a "less than" (<) symbol indicates that the compound was not present above the detection limit of the analytical instrument.

Radiological Parameters	05479 12-18	05939 0 - 6	05942 0 - 6	05943 6 - 12	05944 12 -18
Cs-137	<0.2	<0.2	0.6	<0.2	<0.2
Pu-238	<0.6	<0.6	<0.6	<0.6	<0.6
Pu-239/240	<0.6	<0.6	<0.6	<0.6	<0.6
Ra-226	2.2	1.2	2.3	0.9	1.0
Ra-228	1.1	0.6	1.1	0.8	1.3
Sr-90	<0.5	1.1	1.0	0.8	3.9
Tc-99	44.2	1.5	3.5	<0.9	<0.9
Th-228	1.2	0.7	1.1	0.8	1.1
Th-230	4.4	1.8	5.5	1.5	2.2
Th-232	1.0	0.6	0.8	0.9	1.2
U-234	516.0	3.7	44.8	NA	NA
U-235/236	23.3	<0.6	1.9	NA	NA
U-238	500.0	4.1	42.5	NA	NA

2689

APPENDIX C

C-1

Dose Estimate and Risk Assessment

The following represent a limited assessment of three potential radiation dose paths using the method given in RESRAD[6]. Those paths are external ground radiation, inhalation through resuspension of contaminated soil, and the indirect path to milk.

External Ground Radiation

The assumptions made for this path are:

1. Soil bulk density is 1.8 g/cm^3
2. The potential receptor occupancy and shielding factor is 0.006 (one hour per week)
3. The lateral extent and shape of the surface contamination is extensive and uniform relative to uniform contamination
4. Contamination is uniform in depth to several inches for gamma ray absorption
5. There is no cover attenuating gamma rays
6. The effective dose equivalent conversion factors given in Table B.1 of Reference 6 are used

<u>U-238</u> (Incl. Th-234, Pa-234m)

2391 pCi/g x 1.8 g/cm^3 = 4303.8 pCi/cm^3

4303.8 pCi/cm^3 x 6.97×10^{-2} $mRem/yr/pCi/cm^3$ x 0.006

= 1.8 mRem/yr

<u>U-235</u> (Incl. Th-231)

172 pCi/g x 1.8 g/cm^3 x 4.90×10^{-1} $mRem/yr/pCi/cm^3$ x 0.006

= 0.9 mRem/yr

<u>U-234</u>

1151 pCi/g x 1.8 g/cm^3 x 6.97×10^{-4} $mRem/yr/pCi/cm^3$ x 0.006

= 0.009 mRem/yr

Ra-226

7.7 pCi/g x 1.8 g/cm^3 x 8.56 mRem/yr/pCi/cm^3 x 0.006

= 0.71 mRem/yr

(Th-230 Contribution is negligible)

Ra-228

2.9 pCi/g x 1.8 g/cm^3 x 4.51 mRem/yr/pCi/cm^3 x 0.006

= 0.14 mRem/yr

Th-228 (Incl. 7 daughters)

2.7 pCi/g x 1.8 g/cm^3 x 7.36 mRem/yr/pCi/cm^3 x 0.006

= .22 mRem/yr

(Th-232, Tc-99, Pu-239,40 and Sr-90 contributions are negligible)

Total External Dose Rate

3.8 mRem/yr

Inhalation Pathway

The assumptions made for this path are:

1. Average airborne mass loading is 2 x 10^{-4} g/m^3
2. The potential receptor occupancy factor is 0.006
3. There is no cover over the contaminated soil
4. The distribution of contaminant in the soil extends over a large area and is at depth relative to the surface entrained.
5. Annual air intake is 8400 m^3/yr
6. The committed effective dose equivalent conversion factors given in Reference 6 Table C.1 are used.

<u>U-238</u> (Class Y)

2391 pCi/g x 2 x 10^{-4} g/m^3 x 0.006 x 8400 m^3/yr x 1.2 x 10^{-1} mRem/pCi

= 2.9 mRem/yr

<u>U-235</u> (Class Y)

172 pCi/g x 2 x 10^{-4} g/m^3 x 0.006 x 8400 m^3/yr x 1.2 x 10^{-1} mRem/pCi

= 0.21 mRem/yr

<u>U-234</u> (Class Y)

1151 pCi/g x 1.0 x 10^{-2} g/yr x 1.3 x 10^{-1} mRem/pCi

= 1.5 mRem/yr

(Ra-226 contribution is negligible)

<u>Th-230</u> (Class Y)

17.4 pCi/g x 1.0 x 10^{-2} g/yr x 0.26 mRem/pCi

= 0.05 mRem/yr

(Ra-228 contribution is negligible)

<u>Th-228</u> (Class Y)

2.7 pCi/g x 1.0 x 10^{-2} g/yr x 0.31 mRem/pCi

= 0.008 mRem/yr

(Tc-99, Pu-239,40 and Sr-90 contributions are negligible)

<u>Total Inhalation Dose</u>

4.7 mRem/yr

Milk Pathway

The assumptions made for this path are

1. Vegetative to soil transfer factors are used from Table D.3 of RESRAD[6]
2. Cow forage consumption is 55 kg/day[6]
3. Milk transfer factors are from Table D.4 of RESRAD[6]
4. Human milk consumption is 92 L/yr
5. Ingestion dose factors are from Table D.1 of RESRAD[6]
6. A milking cow ingests all forage for one year from the contaminated area.

Isotope	Soil Concentration	Transfer Factor	Forage Concentration
U-238	2391 pCi/g	2.5×10^{-3}	6.0 pCi/g
U-235	172	2.5×10^{-3}	0.4
U-234	1151	2.5×10^{-3}	2.9
Ra-226	7.7	1.4×10^{-3}	0.01
Th-230	17.4	4.2×10^{-3}	0.07
Ra-228	2.9	1.4×10^{-3}	0.004
Th-228	2.7	4.2×10^{-3}	0.01
Th-232	2.9	4.2×10^{-3}	0.01
Tc-99	4.6	2.5×10^{-1}	1.2
Pu-239,40	1.1	2.5×10^{-4}	3×10^{-4}
Sr-90	1.3	2.0×10^{-1}	0.26

Milk concentrations are estimated given the assumptions in reference 6 including daily cow forage consumption of 55 kg and the milk transfer factors in Table D.4.

Isotope	Forage Concentration		Forage Consumption		Milk Transfer		Milk Concentration
U-238	6 pCi/g	x	5.5×10^{4} g/day	x	6×10^{-4} day/L	=	198 pCi/L
U-235	0.4		5.5×10^{4}		6×10^{-4}		13.2
U-234	2.9		5.5×10^{4}		6×10^{-4}		95.7
Ra-226	0.01		5.5×10^{4}		2×10^{-4}		0.1
Th-230	0.07		5.5×10^{4}		2.5×10^{-6}		0.01
Ra-228	4×10^{-3}		5.5×10^{4}		2.0×10^{-4}		0.04
Th-228	0.01		5.5×10^{4}		2.5×10^{-6}		1×10^{-3}
Th-232	0.01		5.5×10^{4}		2.5×10^{-6}		1×10^{-3}
Tc-99	1.2		5.5×10^{4}		1.2×10^{-2}		792
Po-239,40	3×10^{-4}		5.5×10^{4}		2.5×10^{-8}		4×10^{-7}
Sr-90	0.26		5.5×10^{4}		1.5×10^{-3}		21.5

An annual dose estimate is made based upon ingestion of 92 L of milk per year and using the ingestion dose factors given in Table D.1 of reference 6.

Isotope	Milk Concentration		Milk Consumption		Dose Conversion		Annual Dose
U-238	198 pCi/L	x	92 L/yr	x	2.5×10^{-4} mRem/pCi	=	4.6 mRem/yr
U-235	13.2		92		2.5×10^{-4}		0.3
U-234	95.7		92		2.6×10^{-4}		2.3
Ra-226	0.1		92		1.1×10^{-3}		0.01
Th-230	0.01		92		5.3×10^{-4}		5×10^{-4}
Ra-228	0.04		92		1.2×10^{-3}		4×10^{-3}
Th-228	1×10^{-3}		92		7.5×10^{-4}		7×10^{-5}
Th-232	0.01		92		2.8×10^{-3}		3×10^{-3}
Tc-99	792		92		1.3×10^{-6}		0.09
Pu-239,40	4×10^{-7}		92		4.3×10^{-3}		2×10^{-7}
Sr-90	21.5		92		1.4×10^{-4}		0.3
					Total Milk Dose		7.6 mRem/yr

References

1. Facemire, C.F., Jones, D.L. and Keys, R.W., Feed Materials Production Center Environmental Monitoring Annual Report for 1984, NLO-2028, July 15, 1985, NLO, Inc., Cincinnati, Ohio. (p. 20, Fig. 7) (p. 58, Table 6)

2. Aas, C.A., Jones, D.L., and Keys, R.W., Feed Materials Production Center Environmental Monitoring Report for 1985, FMPC-2047, May 30, 1986, Westinghouse Materials Co. of Ohio, Cincinnati, Ohio.

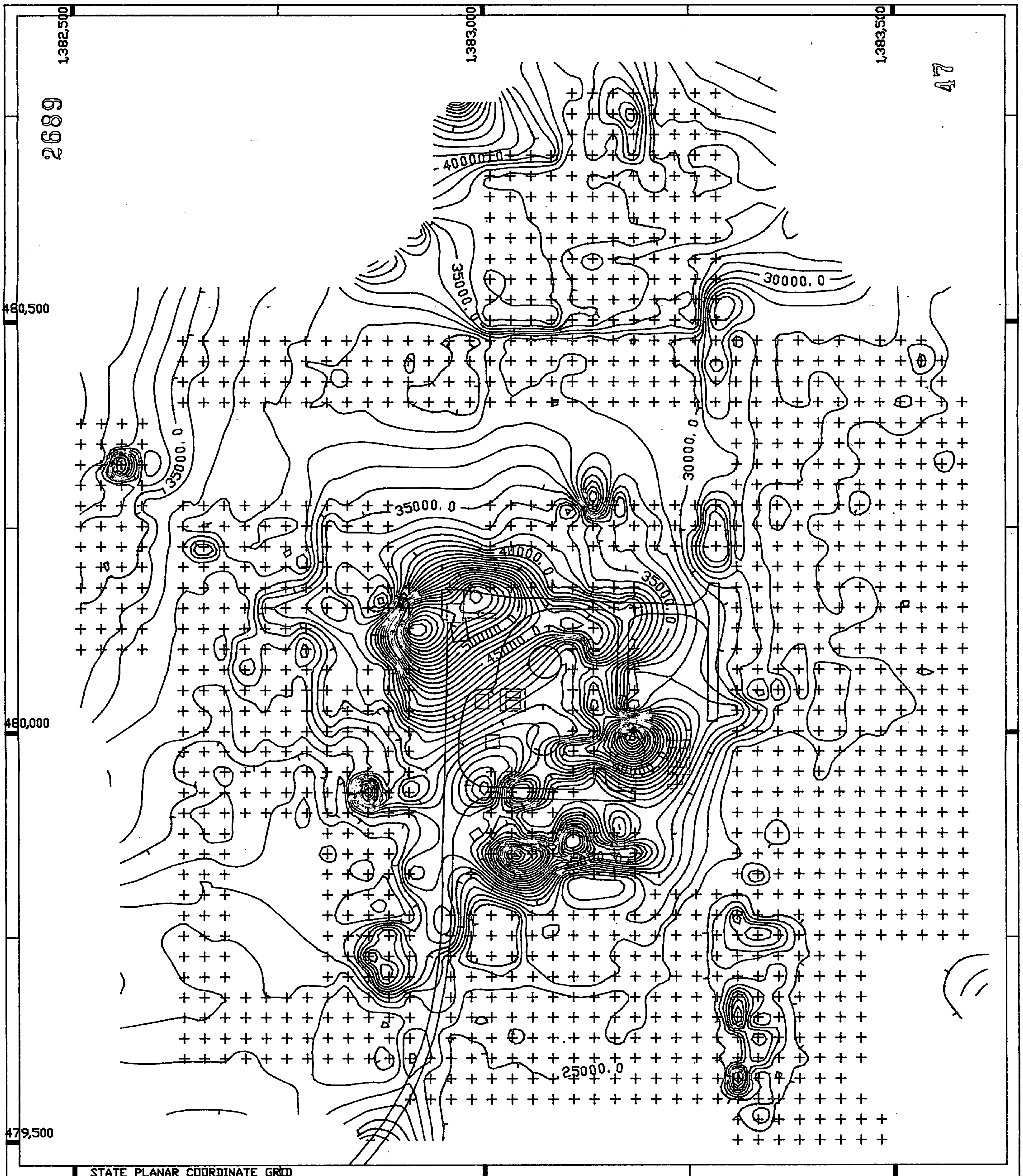
3. Feed Materials Production Center Site Environmental Report for Calendar Year 1989, FMPC-2200, June 25, 1990, Westinghouse Materials Co. of Ohio, Cincinnati, Ohio.

4. U.S. Nuclear Regulatory Commission Branch Technical Position "Disposal or On-Site Storage of Thorium and Uranium Wastes from Past Operations" Fed. Reg. Vol. 46, No. 205, Friday, October 23, 1981, p. 52061 f.

5. 40 CFR 192 Uranium and Thorium Mill Tailings, Subpart B. Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Material from Inactive Uranium Processing Sites.

6. Yu, C., et. al. A Manual for Implementing Residual Radioactive Materials Guidelines, DOE/CH/8901, Argonne National Laboratory, June, 1989.

APPENDIX II



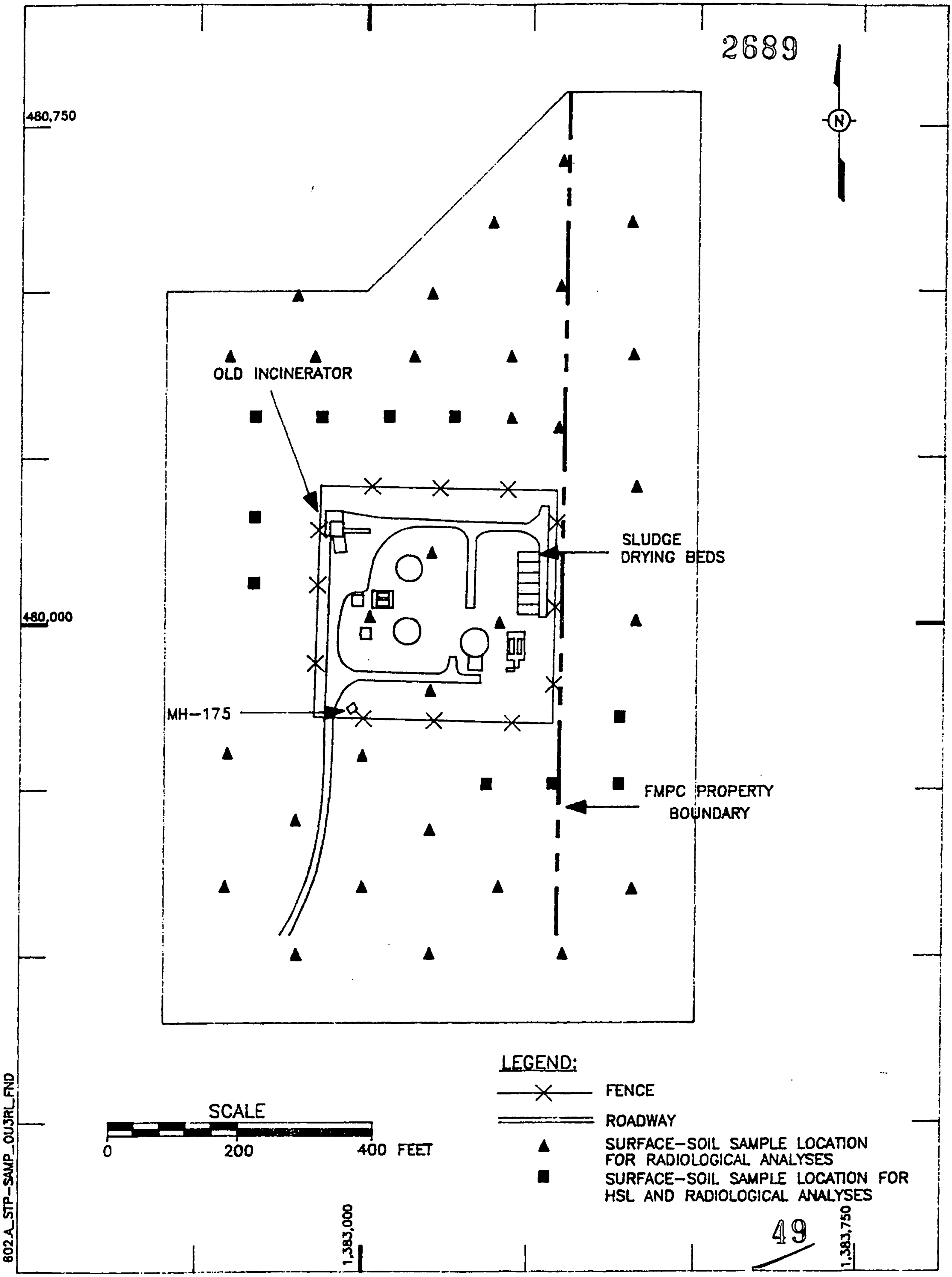
NORMALIZED SPA 3 WALKOVERS
SEWAGE TREATMENT PLANT
REPORTING UNITS = 2 MINUTE COUNTS
CONTOURS INTERVAL = 1000 cpm

SCALE (feet)
0 130 260

SPA STP.PLT FMPCRAD.DWG 1-14-92

APPENDIX III

2689



SEWAGE TREATMENT PLANT – SURFACE SAMPLING LOCATIONS